REMARKS

In the Office Action, claims 1-15, 30 and 32 are rejected. All pending claims are believed to be patentable in their present form, and their reconsideration and allowance are requested.

Rejections Under 35 U.S.C. §102

Claims 1-4, 30, and 32 were rejected under 35 U.S.C. §102(e) as being anticipated by Zickler et al. (article entitled "Helmholtz Stereopsis: Exploiting Reciprocity for Surface Reconstruction"; hereinafter "Zickler").

Zickler is missing features recited by independent claims 1, 30 and 32

Independent claim 1 recites, *inter alia*, "obtaining a Helmholtz reciprocal pair of images of an object, said Helmholtz reciprocal pair of images comprising a first image and a corresponding reciprocal image; determining a geometry associated with said obtaining of said Helmholtz reciprocal pair of images; selecting a plurality of points in said first image and identifying corresponding candidate points in said corresponding reciprocal image; matching a selected point of said plurality of points and a candidate point of said corresponding candidate points."

Similarly, independent claim 30 recites, *inter alia*, "code including instructions for causing a computer to implement a method for image reconstruction, the method comprising: obtaining a Helmholtz reciprocal pair of images of an object, said Helmholtz reciprocal pair of images comprising a first image and a corresponding reciprocal image; determining a geometry associated with said obtaining; selecting a plurality of points in said first image and identifying corresponding candidate points in said corresponding reciprocal image; matching a selected point of said plurality of points and a candidate point of said corresponding candidate points."

Independent claim 32 recites, *inter alia*, "a means for obtaining a Helmholtz reciprocal pair of images of an object, said Helmholtz reciprocal pair of images comprising a first image and a corresponding reciprocal image; a means for determining a geometry associated with said obtaining; a means for selecting a plurality of points in said first image and identifying corresponding candidate points in said corresponding reciprocal image; a means for matching a selected point of said plurality of points and a candidate point of said corresponding candidate points."

Zickler fails to teach or suggest a method of image reconstruction using a *pair of images*, as recited by independent claims 1, 30 and 32. In sharp contrast, Zickler discloses capturing *more than one* Helmholtz reciprocal pair of images.

Zickler discloses a parameterization associated with an arbitrary image, which may be virtual. For any given pixel in this arbitrary image, the depth d^* is associated with the true depth of the point p on the surface that is being observed by this pixel. According to Zickler, given N_p distinct reciprocal image pairs where each image pair consists of an image taken by a camera positioned at location o_l and with light source positioned at o_r as well as a second image in which the camera and light images are reversed, a single linear constraint on p(d) can be derived from the relationship:

$$\left(i_l \frac{\hat{v}_l}{|o_l - p(d)|^2} - i_r \frac{\hat{v}_r}{|o_r - p(d)|^2} \right) \bullet \hat{n} = w(d) \bullet \hat{n} = 0 .$$

It is important to note that i_l is the observed image intensity of the point p(d) projected on to the image associated with the camera centered at o_l and i_r is the image intensity of the point p(d) projected on to the image associated with the camera centered at o_r. Note that both i_r and i_l are real image measurements and that even though a virtual camera can be used to create a depth parameterization, it cannot be used to generate real image intensity measurements and as such cannot contribute to a constraint equation.

Specifically, Zickler teaches:

> If we capture N_p of these reciprocal pairs (each from a different pair of positions o_l, o_r), we will have N_p linear constraints of this form. Let W(d) be the $N_p \times 3$ matrix where the i^{th} row is given by w_i (d) $= \frac{v_{li}}{|o_{li} - p|^2} i_{li} - i_{ri} \frac{v_{ri}}{|o_{ri} - p|^2}$.

Zickler, page 872, lines 14-16.

Further, Zickler teaches:

> Clearly, for the correct depth value d* the surface normal lies in the null space of W(d*), and it can be estimated from a noisy matrix using singular value decomposition. In addition, W(d*) will be rank 2, and this can be used as a necessary condition when searching the depth. Note that at least three camera/light source positions are needed to exploit the constraint.

Zickler, page 872, lines 17-21.

Hence, Zickler clearly suggests that at least 3 constraints are needed to uniquely determine the value of d^*. Clearly, also, each of these constraints is based on a unique reciprocal pair. In contrast, the claimed technique requires only a single reciprocal pair in order to achieve a full reconstruction.

Moreover, and significantly, Zickler teaches selecting and matching images *between* image pairs and not selecting and matching images *within* a pair, as recited in independent claims 1, 30 and 32. Specifically, Zickler discloses:

Given a point q in the principal image, there is a one-parameter family of n-point sets $\{q_1, \ldots\ldots, q_n\}$ in the ***other images*** that correspond to q.

Zickler, page 871, lines 12-14, (emphasis added).

The claimed matching of points in a pair of reciprocal images is simply not performed or even suggested by Zickler.

In view of these deficiencies, Zickler clearly does not anticipate claims 1-4, 30 and 32. Hence, Applicants respectfully request withdrawal of the rejections under 35 U.S.C. § 102.

Rejections Under 35 U.S.C. §103

Claim 5 was rejected under 35 U.S.C. §103(a) as being unpatentable over Zickler in view of Gerig et al. (U.S. Patent No. 5,446,548, hereinafter "Gerig"). Claim 5 is believed to be clearly patentable at least by virtue of dependency upon allowable base claim 1.

Claims 6-13 and 15 were rejected under 35 U.S.C. §103 as being unpatentable over Zickler in view of Tu et al. (paper entitled "Surface reconstruction via Helmholtz Reciprocity with a single Image Pair"; hereinafter "Tu"). Claims 6-13 and 15 are believed to be clearly patentable at by virtue of dependency upon allowable base claim 1.

Claim 14 was rejected under 35 U.S.C. §103 as being unpatentable over Zickler in view of Tu in further view of Saund (U.S. Patent No. 5,835,241, hereinafter "Saund"). Claim 14 is believed to be clearly patentable at least by virtue of dependency upon allowable base claim 1.

Allowable subject matter

Claims 16-29, 33 and 35 were allowed.

Conclusion

In view of the remarks and amendments set forth above, Applicants respectfully request allowance of the pending claims. If the Examiner believes that a telephonic interview will help speed this application toward issuance, the Examiner is invited to contact the undersigned at the telephone number listed below.

Respectfully submitted,

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